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The Drivers of Employees' Active Innovative Behaviour in Chinese High-Tech Enterprises

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Abstract: High-performance work systems are being increasingly used in organisational management. However, such system development over time has resulted in increasingly complex impacts on employee innovation behaviour. How to stimulate innovation in the technological talent pool of individuals at high-tech enterprises has gradually become a research hotspot. Based on an effective sample of 351 technological individuals from high-tech enterprises in Jiangsu, Zhejiang and Guangdong provinces, this paper discusses the mechanism and boundary conditions of a high-performance work system affecting the active innovation behaviour of such individuals based on self-determination theory. The empirical results show the following: (1) Informational practices and controlled practices in a high-performance work system have mutually exclusive effects on active innovation behaviour, with significant positive and negative effects. (2) The need for autonomy and competence play mediating roles between informational practices and active innovation behaviour; the need for autonomy plays a masking effect between controlled practices and active innovation behaviour. (3) The need for relatedness negatively moderates the effects of a high-performance work system which is focused on the needs for autonomy and competence. The findings reveal the internal mechanism and boundary conditions of high-performance work system influencing active innovation behaviour, which provides a reference for high-tech enterprises to encourage technical talents to innovate, and have important practical significance for improving the core competitiveness of high-tech enterprises.

Keywords: active innovation behaviour; high-performance work system; self-determination theory; technological talent pool; China

Citation: Fan, C.; Hu, M.; Shangguan, Z.; Ye, C.; Yan, S.; Wang, M.Y. The Drivers of Employees' Active Innovative Behaviour in Chinese High-Tech Enterprises. *Sustainability* **2021**, *13*, 6032. https://doi.org/10.3390/su13116032

Academic Editor: Pedro Núñez-Cacho

Received: 5 May 2021
Accepted: 24 May 2021
Published: 27 May 2021

1. Introduction

Since the commencement of the trade war between China and the United States on 22 March 2018, the United States has imposed sanctions on many Chinese high-tech enterprises [1,2]. Such sanctions include prohibiting American enterprises from selling parts, products, software and technology to ZTE and adding Huawei and 70 of its affiliates to the "Entity List", prohibiting them from purchasing components and technologies for the supply and production of high-end chips and eliminating their right to use the operating systems and established technological standards of American enterprises. This trade war has left China's high-tech enterprises in a passive position because their core technologies rely heavily on the United States. Therefore, against the background of the trade war between China and the United States, the technological innovation of the talent pool of individuals in China's high-tech enterprises is particularly important. For a long time, technological talent in China has been affected by an enterprise's "high-intensity" management mode and "quantification-only" evaluation mechanism, which forced technicians to engage

in herding, coping, utilitarianism behaviour, etc., for short-term benefits, thus neglecting time in being innovative which requires considerable time and energy [3]. As a result, enterprises in China have little incentive to innovate. Therefore, motivating individuals working at China's high-tech enterprises to practise active innovation has important practical significance for improving the core competitiveness of China's high-tech enterprises. More importantly, one of the essences of the trade war between China and the United States is science and technology blockades. The only way China can become a true leading power in the world is by motivating the scientific and technological talent pools' initiative in practising scientific and technological innovation within their high-tech enterprises.

The current academic studies on active innovation behaviour show that this behaviour is influenced by three factors: individual characteristics, leadership factors and organisational factors. First, individual characteristics are mainly reflected in an individual's personality traits [4], cognitive (or thinking) style [5] and work motivation [6]. For example, when leaders have high expectations for creativity, this has a positive influence on the individual's creativity [7]. Second, academics have discussed the influence of leadership factors such as leadership types [8], the relationship between leadership and subordinates [9], etc. Hansen and Pihl-Thingvad [10] stated that the combination of transformational leadership and verbal praise (an element of transactional leadership) is more likely to produce innovation behaviour. Third, the role of organisational factors is not insignificant. Aspects such as organisational structure [11], organisational innovation atmosphere [12] and organisational culture [13] have certain influences on an individual's innovation behaviour. However, academics have begun to challenge these doctrines. Based on self-determination theory, academics have studied active innovation behaviour from a psychological perspective. The results of one study show that the basic psychological needs of the individual form the internal motivation of active innovation [14]. According to self-determination theory, an individual's active behaviour is influenced by the three psychological needs of autonomy, competence and relationships [15]. The satisfaction of the need for autonomy fuels one's motivation to be innovative; fulfilling the need for competence emphasises the confidence of an individual in their own abilities to be innovative in their work, and the satisfaction of the need for relationships allows the individual to experience peer recognition and support for being innovative [16]. In addition, a study [17] stated that the satisfaction of the need for relationships essentially puts an individual in a situation of security and intimacy, which also supports the need for autonomy and competence. It is worth noting that in the cultural atmosphere of China's specific "relationship orientation", the need for relationships plays a vital role in the development of employees [18]. Therefore, the need for relationships has strong applicability when analysing the active innovation behaviour of the technological talent pool in China's high-tech enterprises from a psychological perspective. Based on self-determination theory, this paper examines the talent pool of select Chinese high-tech enterprises by taking the need for autonomy, competence and relationships as the internal motivations of active innovation.

Currently, a high-performance work system (HPWS) is generally adopted in China's high-tech enterprises, and this system is the best combination of a series of human resource management practices (HRMPs) that can improve an enterprises' performance [19]. This paper focuses on the motivational mechanism of active innovation in individuals working in China's high-tech enterprises under this system. In an era of a trade war, this paper explores two issues: first, whether a high-performance work system can motivate the active innovation behaviour of technological talent in China's high-tech enterprises; and second, how the three internal motivations of the need for autonomy, competence and relationships influence an individual's active innovation behaviour. These research results not only provide empirical basis for revealing the "black box" of the relationship between HPWS and active innovation behaviour but also provide theoretical basis that can be used by China's high-tech enterprises to improve innovation behaviour of their employees' technicians during this trade war. At the same time, it is helpful to open up the thinking direction of future research on the effectiveness of HPWS.

2. Hypothesis Development

2.1. HPWS and Active Innovation Behaviour

The most common functions of HPWS include enhancing innovation [20], promoting organisational performance [21] and improving sustainable competitive advantages [22]. According to the resource-based view (RBV) [23,24], the staffing and training practices of HPWS will undoubtedly help acquire and develop critical knowledge, skills and abilities for active innovation behaviour. Meanwhile, performance appraisals and performance-based compensation systems may motivate employees to create and realise ideas [25]. Additionally, empowerment-based work designs, participation in decision making and freedom to make decisions will provide employees with open opportunities to take risks and apply innovative ideas [25]. However, according to cognitive evaluation theory [26], all external events can be considered to have two functional aspects: the control aspect and the information aspect. Informational events promote the perception of an internal locus of causality and competence, thereby increasing the level of internal motivation; controlling events produce stress that increases the perception of an external locus of causality and reduces the sense of autonomy, thereby weakening internal motivation [17]. Therefore, in the practice of HPWS, we can also divide them into informational practices (IPs) and controlled practices (CPs).

At present, there is no clear division between IP and CP in HPWS management. However, existing research shows that vocational training, information symmetry and employee voice can effectively improve active innovation behaviour [27]. Boxall et al. [28] stated that employee selection and career development are related to training. Their research also indicated that new employees need special preparation and cultural indoctrination to adapt them to new work norms, which is the basis for stimulating their initiative and innovation. Wang and Sun [29] found that information sharing and job rotation in enterprises can enable employees to obtain the information they need at work, which is conducive to broadening their thinking, generating more new ideas and stimulating their willingness to innovate. Dyne et al. [30] and Hao et al. [31] explained that voice behaviour is an attempt by employees to bring positive changes and improvements to an organization. When an organisation promotes advocacy, it will certainly encourage employees to actively consider organisational issues, thereby promoting organisational learning. The increase in learning will lead to several changes and improvements in procedures, administration, the organisation itself and technology. These changes and improvements will eventually be reflected in innovative products and services.

Unlike the research of Wright and Kehoe [25], some studies have also found that a strict and rigid performance-appraisal system will inhibit the active innovation behaviour of employees [3]. High-standard work requirements and high-intensity workloads will make employees feel more oppressed such that they are unwilling to take the risk of trying new methods [32]. In addition, a strict performance-appraisal system would subject employees to the "performance" principle and control their motivation; this would decrease employees' autonomy and creativity and lower individual performance [33].

At present, Chinese academic circles are currently focused on the debatable question "Does an HPWS stimulate or inhibit employees' innovation behaviour?" [9]. To clarify the impact of HPWS on innovative behaviour in Chinese high-tech enterprises, using the studies above and comprehensively considering the characteristics of China's HPWS, we classified the practices related to skills training, information symmetry and voice behaviour as IP and classified performance appraisals as CP. Although the practices of HPWS in various Chinese high-tech enterprises may make different adjustments during the special period of the trade war, based on the studies of different scholars in each period, we have reason to believe that the overall trend of HPWS influence on active innovation behaviour will not change greatly during the trade war. Therefore, we proposed the following hypotheses:

Hypothesis 1 (H1). *The IP in HPWS is positively associated with active innovation behaviour.*

Hypothesis 2 (H2). *The CP in HPWS is negatively associated with active innovation behaviour.*

2.2. The Mediating Roles of the Needs for Autonomy and Competence

The need for autonomy refers to an individual's sense of control over their behaviour and psychological freedom [34]. The need for competence involves the feeling of control over the environment and the innate tendency to explore [35]. HPWS provides a wide range of support for the needs for autonomy and competency of employees [36,37]. HPWS increases psychological capital such as self-realisation, flexibility and hope by increasing the exchange of information between employees and an organisation. Furthermore, HPWS also improves problem-solving and interpersonal skills through various training programs, thereby contributing to self-efficacy, psychological ownership and psychological security, thereby making individuals more hopeful and confident in achieving their goals. Strict and rigid performance appraisals have also been proven to make an employee's need for autonomy unsatisfied [38]. The research also showed that the increase in global competitive pressure and the deterioration of a company's working conditions would make HPWS exert more pressure on employees during the trade war period, which reduces the employee's sense of competence [39]. Thus, it is clear that HPWS has a direct impact on the needs for autonomy and competence.

According to self-determination theory, to understand human motivations, the needs for autonomy and competence should be considered since they explain the relationship between psychological needs and behaviour [40]. Studies have shown that the satisfaction of the need for autonomy plays a positive role in the creation of ideas [41], advocacy [42] and creative implementation [43]. Volmer et al. [44] believed that the talent pool tends to be responsible for work results and conduct creative activities when they have control over the content and form of their work. Moreover, innovative work usually has the characteristics of challenge, risk and complexity. When individuals are supported by enterprises, they are more likely to experience positive emotions during creative work [45]. Related research has also concluded that the need for competence promotes innovative behaviour [46–48]. It fuels motivation, use of cognitive resources and the taking of various courses of action required to meet situational demands. Individuals will spend more time identifying problems and generating creative solutions, and then they will work harder to seek help and produce prototypes. Therefore, they can proactively complete specific tasks in the face of obstacles and achieve organisational innovation goals [49]. Seligman and Csikszentmihalyi [50] believed that when employees are confident in completing a specific task, they can successfully cope with failure and uncertainty, thereby completing active innovation behaviour.

Based on the research above, we determined that HPWS has a direct impact on the needs for autonomy and competence and the various practices of HPWS can help employees implement active innovation behaviour by fulfilling their need for autonomy and competence. Consequently, we asserted that the needs for autonomy and competence mediate the relationship between employees' HPWS and active innovation behaviour. Therefore, we proposed the following hypotheses:

Hypothesis 3 (H3). *The need for autonomy mediates the relationship between HPWS and active innovation behaviour.*

Hypothesis 4 (H4). *The need for competence mediates the relationship between HPWS and active innovation behaviour.*

2.3. The Moderating Role of the Need for Relatedness

The need for relatedness refers to good interpersonal relationships with others and support from others [51]. In a specific Chinese cultural context, "guanxi" plays an essential role in career promotion, smooth work implementation and resource mobilisation [52]. The need for relatedness has also been shown to promote the needs for autonomy and

competency [17]. Many studies also support the fact that such a need plays a positive regulating role in enterprise management and the needs for autonomy and competency [53].

According to social capital theory [54], social capital exists in the form of reciprocity, trust and network connection [55], enabling individuals to obtain the benefits of information, power and solidarity [54]. When employees' need for relatedness is satisfied, they are more likely to obtain resources and valuable information in their enterprises [52]. The more information resources employees have, the more accurate decisions they will make, and the more likely they will be to be recognised by superiors and the overall organisation [56], thus satisfying their need for competency. Cheng et al. [57] stated that managers in Chinese organisations always distinguish employees based on relationship quality. Out of favouritism, a superior may grant privileges to employees with good connections. These employees have autonomy when conducting their work, can better perform innovative work and obtain promotion and reward opportunities [58,59]. Moreover, when employees have good interpersonal trusting relations and colleagues are united, they can obtain help from team members when facing difficult innovation tasks, thus enhancing their confidence in overcoming difficulties.

Based on the above research, we determined that the degree of satisfaction of the need for relatedness determines the impacts of HPWS practices on employees' needs for autonomy and competency. Consequently, we believed that the need for relatedness moderates the relationship between HPWS and the needs for autonomy and competence. Therefore, we proposed the following hypotheses:

Hypothesis 5 (H5). *The need for relatedness moderates the relationship between HPWS and the need for autonomy, such that a positive relationship between HPWS and the need for autonomy is stronger for employees who have good relationships with their managers and peers than those who do not.*

Hypothesis 6 (H6). *The need for relatedness moderates the relationship between HPWS and the need for competence, such that a positive relationship between HPWS and the need for competence is stronger for employees who have good relationships with their managers and peers than those who do not.*

Based on the above hypothesis, this study proposed a moderated mediation model (as shown in Figure 1). The need for relatedness moderates the mediated relationship between HPWS and active innovation behaviour through the needs for autonomy and competence. When the satisfaction of the need for relatedness is high, it is easier for employees to perceive and understand the positive significance of HPWS implementation and obtain more information resources, privileges and interpersonal trust so that employees' needs for autonomy and competence can be better satisfied, thereby enhancing their active innovation behaviour. In contrast, when the satisfaction of the need for relatedness is low, employees cannot receive the information delivered by HPWS, which is not only detrimental to the improvement of knowledge and skills, but it also ignores the role of interpersonal relationships. This reduces work autonomy and self-efficacy, thus decreasing active innovation behaviour.

Hypothesis 7 (H7). *The need for relatedness moderates the positive indirect relationship between HPWS and active innovation behaviour through the need for autonomy such that the indirect effect is stronger when the need for relatedness is high.*

Hypothesis 8 (H8). *The need for relatedness moderates the positive indirect relationship between HPWS and active innovation behaviour through the need for competence such that the indirect effect is stronger when the need for relatedness is high.*

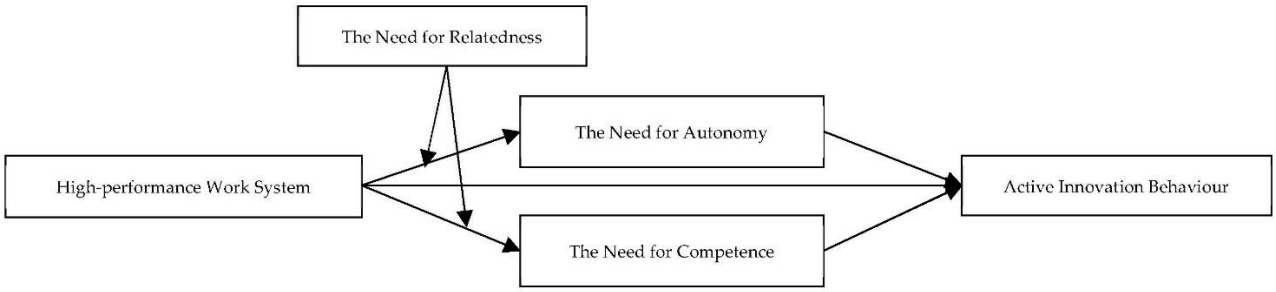

Figure 1. The proposed moderated mediation model.

3. Methods and Methodology

3.1. Participants and Procedures

This paper focuses on the technical talent pool in high-tech enterprises in Jiangsu, Zhejiang and Guangdong. These enterprises are highly concentrated in the developed southeastern coastal provinces. This sampling adopts the following two methods: (1) electronic questionnaires sent via email to the employees; and (2) for those who did not respond to the email, we collected questionnaires via on-site interviews to increase the response rate. These email and field questionnaires were completed in April 2020. A total of 450 questionnaires were sent out, and 415 were recovered, resulting in a recovery rate of 92.2%. In total, 64 invalid questionnaires were excluded, and 351 valid questionnaires were valid. Therefore, the recovery rate of useful questionnaires was 77.2%. The sample characteristics are shown in Table 1.

Table 1. Descriptive statistics.

Sample Characteristics	Classification Standard	Frequency	Proportion (%)
Gender	Male	226	64.4%
	Female	125	35.6%
Age	≤25 years old	30	8.5%
	26–35 years old	188	53.6%
	36–45 years old	57	16.2%
	>45 years old	76	21.7%
Education	Doctorate	47	13.4%
	Postgraduate	152	43.3%
	Undergraduate	130	37.0%
	Junior College and below	22	6.3%
Working years	0–1 years	63	17.9%
	1–3 years	39	11.1%
	3–5 years	55	15.7%
	5–10 years	76	21.7%
	>10 years	118	33.6%

In terms of gender, 64.4% of the respondents were male, and 35.6% were female. According to the second National Survey of Science and Technology Workers in 2008, 64% of the employees who engaged in basic research were male, which is consistent with our sample. In terms of age, 8.5% of the respondents were under 25 years old, 53.6% were between 26 and 35 years old, 16.2% were between 36 and 45 years old, and 21.7% were over 45 years old. In the sample, those aged between 26 and 35 years old were the majority, indicating that the workforce of China's high-tech enterprises is getting younger. In terms of educational background, 56.7% of the respondents had doctorate or other postgraduate degrees, indicating that the sample population has a high level of education. In terms of working years, 17.9% of the respondents had worked between 0 and 1 year, 11.1% had worked between 1 and 3 years, 15.7% had worked between 3 and 5 years, 21.7% had

worked between 5 and 10 years, and 33.6% had worked more than ten years. A total of 55.3% had worked for more than five years, indicating that the sample population has rich working experience. The data below also show that the sample was mostly male and most were relatively young. The proportion of highly educated personnel is relatively large. The sample as a whole conforms to the basic situation of the Third Survey Report on the State of Science and Technology Workers in China released by the Association for Science and Technology in 2018. This sample is valid for the issue examined in this paper.

3.2. Measures

To improve reliability and validity, the scales used in this study were all mature scales. In addition to the control variables, all items were measured using a seven-point Likert scale (from 1 = strongly disagree to 7 = strongly agree). The questionnaire design is shown in Appendix A.

High-performance Work System: We referred to the HPWS scale developed by Wang [60] based on the Chinese context and combined it with Wang and Sun [29], emphasising that HPWS includes informational practices and controlled practices. This 11-item scale was divided into two dimensions: informational practices and controlled practices. A sample item was "Standardised employee performance assessment management method in the enterprise". The Cronbach's alpha coefficients were 0.95 and 0.95 for informational practices and controlled practices, respectively.

Need for Autonomy, Competence and Relatedness: We utilised the basic psychological needs questionnaire developed by Gagné [61] and revised the initial measurement items according to the interview content by using the grounded theory method. The 13-item scale was divided into three dimensions: the need for autonomy, competence and relatedness. A sample item was "I can take different ways of working in work". The Cronbach's alpha coefficients were 0.91, 0.93 and 0.91 for the need for autonomy, the need for competence and the need for relatedness, respectively.

Active Innovation Behaviour: We revised the active innovation behaviour questionnaire developed by Zhao et al. [3]. The 13-item scale was divided into the three dimensions of spontaneity, preliminary preparation and obstacle crossing. A sample item was "I try to overcome the difficulties encountered in the process of innovation". The Cronbach's alpha coefficients were 0.92, 0.84 and 0.98 for spontaneity, preliminary preparation and obstacle crossing, respectively. Additionally, to avoid interference from other variables, gender, age, education and working years were used as control variables.

4. Results

4.1. Model Testing

4.1.1. Common Method Variance

The measurement of an HPWS is at the individual level and measures employees' perception of the HPWS, surveying the employees themselves and their basic psychological needs simultaneously. Co-varying human factors affect the relationships between variables, and homology bias may exist. In order to avoid common method variance, this paper adopted two methods: program control and statistical control. First, the questionnaire indicated to employees that "this questionnaire is only used for academic research, all data are anonymously collected and will never be used for any commercial purposes". Second, the Harman one-factor test was applied in this study to conduct unrotated exploratory factor analysis on all items. There were six factors with characteristic roots greater than 1; and the total variation explained was less than 50%. Additionally, the common method factor (CMF) was added based on the six-factor model to construct the seven-factor model. The comparison of the main fitting indexes of the six-factor model and the seven-factor model was as follows: $\triangle$TLI = 0.02, $\triangle$CFI = 0.02, $\triangle$NFI = 0.03, $\triangle$IFI = 0.02, and $\triangle$RMSEA = 0.01. The change in each fitting index was less than 0.04, indicating that the model had not been significantly improved after adding the common method factor, and there was no issue of common method variance in the data.

4.1.2. Discriminant Validity

To avoid low discriminant validity, this study used the AMOS 23.0 software to perform confirmatory factor analysis. The six-factor model fit indexes, as shown in Table 2 (χ^2/df = 2.52, TLI = 0.93, CFI = 0.94, RMSEA = 0.07, and SRMR = 0.04), revealed that fit was better than other models, indicating that each variable in the theoretical model had good discriminant validity.

Table 2. Confirmatory factor analysis results of concept discrimination validity.

Model	Model Combination	χ^2	df	TLI	CFI	RMSEA	SRMR
Six-factor model	IP; CP; Re; Au; Co; AIB	842.46	335	0.93	0.94	0.07	0.04
Five-factor model	IP + CP; Re; Au; Co; AIB	1307.31	340	0.88	0.89	0.09	0.08
Four-factor model	IP; CP; Re + Au + Co; AIB	1307.20	344	0.88	0.89	0.09	0.06
Three-factor model	IP + CP; Re + Au + Co; AIB	1765.71	347	0.82	0.84	0.11	0.09
Two-factor model	IP + CP + Re + Au + Co; AIB	2789.76	349	0.70	0.72	0.14	0.10
One-factor model	IP + CP + Re + Au + Co + AIB	4630.88	350	0.47	0.51	0.19	0.15

Note: IP, informational practice; CP, controlled practice; Re, the need for relatedness; Au, the need for autonomy; Co, the need for competence; AIB, active innovation behaviour; + represents two factors to synthesize a variable, as follows.

4.2. Descriptive Statistics and Correlation Analysis

This study conducted Pearson's correlation analysis between HPWS and active innovation behaviour using SPSS 21.0 software to obtain the mean, standard deviation, and correlation co-efficients for each variable (as shown in Table 3). Active innovation behaviour and IP (r = 0.44, $p < 0.01$), CP (r = −0.21, $p < 0.01$), the need for relatedness (r = 0.34, $p < 0.01$), the need for autonomy (r = 0.38, $p < 0.01$) and the need for competence (r = 0.44, $p < 0.01$) were significantly correlated with each other. Hypothesis 1 and Hypothesis 2 were initially supported, indicating that conditions were available for subsequent statistical tests of the structural equation model.

Table 3. Mean, standard deviation and correlations of variables.

Variables	M	SD	Variables									
			1	2	3	4	5	6	7	8	9	10
1. Gender	1.36	0.48										
2. Age	2.51	0.93	0.02									
3. Education	2.36	0.79	0.09	−0.01								
4. Working years	3.42	1.49	0.02	0.68 **	0.21 **							
5. IP	5.18	1.25	0.02	−0.27 **	0.13 *	−0.24 **						
6. CP	4.17	1.35	0.03	0.13 *	−0.06	0.16 **	0.20 **					
7. Re	5.86	0.79	−0.04	−0.10	0.08	−0.07	0.53 **	0.17 **				
8. Au	4.72	1.23	0.03	−0.21 **	0.12 *	−0.13 *	0.63 **	0.24 **	0.59 **			
9. Co	5.24	1.27	−0.04	−0.25 **	0.13 **	−0.17 **	0.60 **	0.11 *	0.67 **	0.69 **		
10. AIB	4.97	1.31	−0.05	−0.20 **	0.20 **	−0.17 **	0.44 **	−0.21 **	0.34 **	0.38 **	0.44 **	

Note: N = 351, * means $p < 0.05$, ** means $p < 0.01$, *** means $p < 0.001$ (bilateral inspection), as follows.

4.3. Hypotheses Testing

AMOS 23.0 software was used to analyse the relationship between HPWS and active innovation behaviour, and a structural equation model was preliminarily constructed to test whether the needs for autonomy and competence mediate the relationship between HPWS and active innovation behaviour. The results are as follows: χ^2/df = 3.06, TLI = 0.92, IFI = 0.93, CFI = 0.93, and RMSEA = 0.08. All indexes met the acceptable standards, resulting in a good fit of the mediating effects structural model to the data.

4.3.1. Path Analysis of the Direct Effects

In this paper, the structural equation test model was used to obtain the test results of the hypothesised direct effect (as shown in Table 4). The results show that Hypothesis 1

and Hypothesis 2 were supported. Furthermore, we can find that CP has a more significant impact on active innovation behaviour than IP.

Table 4. Direct effect test.

Hypothesis	Path			Std. Estimate	SE	CR	*p*
H1	IP	→	AIB	0.25	0.08	3.57	***
H2	CP	→	AIB	−0.36	0.05	−6.70	***
Other	IP	→	Au	0.65	0.07	11.21	***
	IP	→	Co	0.61	0.06	10.73	***
	CP	→	Au	0.12	0.05	2.35	0.02
	CP	→	Co	0.02	0.05	0.41	0.68
	Au	→	AIB	0.18	0.08	3.63	***
	Co	→	AIB	0.26	0.08	2.23	0.03

Note: $N = 351$, * means $p < 0.05$, ** means $p < 0.01$, *** means $p < 0.001$ (bilateral inspection), as follows.

4.3.2. The Mediating Effect Test between the Needs for Autonomy and Competency

In this paper, the bootstrapping test method proposed by Taylor et al. [62] was used to test the mediating effects of HPWS on the four paths of active innovation behaviour through the needs for autonomy and competency. The results are shown in Table 5.

Table 5. Bootstrap test for mediating effect (standardisation).

Indirect Effect	Estimates	Product of Coefficients		Bias-Corrected 95%CI		
		Boot SE	Z	Lower	Upper	*p*
IP→Au→AIB	0.12	0.06	2.05	0.01	0.23	0.03
CP→Au→AIB	0.02	0.02	1.33	0.01	0.06	0.04
IP→Co→AIB	0.16	0.04	3.71	0.08	0.25	0.01
CP→Co→AIB	0.01	0.01	0.36	−0.02	0.04	0.61

The value of the indirect effect of informational practices on active innovation behaviour through the need for autonomy was 0.12 (SE = 0.06), which was significant according to the 95% confidence interval of the bias-corrected percentile method ($p = 0.03 < 0.05$). The value of the indirect effect of controlled practices on active innovation behaviour through the need for autonomy was 0.02 (SE = 0.02), which was significant according to the 95% confidence interval of the bias-corrected percentile method ($p = 0.04 < 0.05$). However, the sign of the value of the indirect effect was contrary to the sign of the value of direct effect ($C' = -0.36$). According to the mediation effect determination procedure proposed by Wen and Ye [63], such an indirect effect is manifested as a "masking effect". In other words, the indirect effect of the need for autonomy weakened the direct effect of controlled practices on active innovation behaviour, which meant that controlled practices had a significant positive impact on active innovation behaviour through the need for autonomy. Therefore, Hypothesis 3 was supported.

The value of the indirect effect of informational practices on active innovation behaviour through the need for competence was 0.16 (SE = 0.04), which was significant according to the 95% confidence interval of the bias-corrected percentile method ($p = 0.01 < 0.05$). The value of the indirect effect of controlled practices on active innovation behaviour through the need for competence was 0.01 (SE = 0.01), which was not significant according to the 95% confidence interval of the bias-corrected percentile method ($p = 0.61 > 0.05$). Therefore, Hypothesis 4 was partially supported.

4.3.3. The Moderating Effect Test of the Need for Relatedness

To test the moderating effect of the need for relatedness on the relationship between HPWS and the needs for autonomy and competency, SPSS 21.0 software was used to perform hierarchical regression analysis on the moderating effect. To avoid the problem

of multicollinearity, all variables were standardised in this paper. The results in Table 6 show that the need for relatedness had a significant negative moderating effect on the relationships between IP (M3, β = −0.09, $p < 0.05$), CP (M5, β = −0.16, $p < 0.001$) and the need for autonomy. Therefore, Hypothesis 5 was not supported. The need for relatedness had a significant negative moderating effect on the relationships between IP (M8, β = −0.08, $p < 0.05$), CP (M10, β = −0.08, $p < 0.01$) and the need for competence. Therefore, Hypothesis 6 was not supported.

Table 6. Moderating effect tests of the need for relatedness.

Variables	The Need for Autonomy					The Need for Competence				
	M1	**M2**	**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**
Control variables										
Gender	0.02	0.04	0.03	0.04	0.04	−0.05	−0.03	−0.04	−0.03	−0.04
Age	−0.18 **	−0.09	−0.09	−0.15 *	−0.13 *	−0.21 **	−0.13 *	−0.12 **	−0.13 *	−0.12 *
Education	0.11 *	0.01	0.02	0.08	0.10 *	0.14 **	0.05	0.06	0.05	0.06
Working years	−0.03	0.06	0.05	−0.04	−0.05	−0.06	0.02	0.01	0.02	0.01
Independent variables										
IP		0.42 ***	0.41 ***				0.31 ***	0.30 ***		
CP				0.18 ***	0.19 ***				0.31 ***	0.30 ***
Moderator variable										
Re		0.37 ***	0.34 ***	0.54 ***	0.51 ***		0.49 ***	0.46 ***	0.49 ***	0.46 ***
Interaction										
IP*Re			−0.09 *					−0.08 *		
CP*Re					−0.16 ***					−0.08 **
R^2	0.06	0.49	0.50	0.42	0.44	0.08	0.54	0.55	0.48	0.49
F	5.01 **	56.45 ***	49.49 ***	40.17 ***	37.89 ***	7.67 ***	68.76 ***	60.15 ***	53.81 ***	47.73 ***
$\triangle R^2$		0.43	0.01	0.36	0.02		0.46	0.01	0.40	0.01
△F		150.68 ***	4.37 *	104.51 ***	14.62 ***		175.47 ***	4.40 *	134.28 ***	6.26 **

Note: $N = 351$, * means $p < 0.05$, ** means $p < 0.01$, *** means $p < 0.001$ (bilateral inspection), as follows.

4.3.4. The Moderating Mediating Effect Test

In this paper, the bootstrap method proposed by Hayes and Rockwood [64] was used to test the moderating mediating effect, and the results are shown in Table 7. When the need for relatedness was lower, the impacts of informational practices in HPWS on active innovation behaviour through the needs for autonomy and competency were both significant with 95% confidence intervals of [0.02, 0.17] and [0.04, 0.16], respectively. The impacts of controlled practices in HPWS on active innovation behaviour through the needs for autonomy and competency were both significant with 95% confidence intervals of [0.08, 0.21] and [0.01, 0.13], respectively. When the need for relatedness was higher, the impacts of informational practices on active innovation behaviour through the needs for autonomy and competency were significant, with 95% confidence intervals of [0.02, 0.12] and [0.02, 0.12], respectively. The effects of controlled practices in HPWS on active innovation behaviour through the needs for autonomy and competency were not significant, with 95% confidence intervals of [−0.03, 0.06] and [−0.06, 0.02], respectively. These results indicate that the indirect relationship between HPWS and active innovation behaviour through the needs for autonomy and competency was weaker when the need for relatedness was higher, and Hypothesis 7 and Hypothesis 8 were not supported.

Table 7. Testing of the moderated mediation effect based on moderation path analysis.

Path	Grouping Statistics	Boot Effect	Boot SE	BootLLCI	BootULCI
IP→Au→AIB	−1SD	0.09	0.04	0.02	0.17
	+1SD	0.06	0.03	0.02	0.12
CP→Au→AIB	−1SD	0.14	0.03	0.08	0.21
	+1SD	0.02	0.02	−0.03	0.06
IP→Co→AIB	−1SD	0.09	0.03	0.04	0.16
	+1SD	0.06	0.02	0.02	0.12
CP→Co→AIB	−1SD	0.06	0.03	0.01	0.13
	+1SD	−0.02	0.02	−0.06	0.02

5. Discussion

5.1. Theoretical Implications

Against the background of the trade war, this paper studies the relationship between HPWS and active innovation behaviour, the mediating effects of the needs for autonomy and competence and the moderating effect of the need for relatedness. The theoretical contributions of the paper are as follows:

5.1.1. The Relationship between HPWS and Active Innovation Behaviour

This study helps to clarify the complex relationship between HPWS and the active innovation behaviour of the technological talent pool. Although previous studies have found that factors such as individual characteristics and leadership characteristics influence the innovation behaviour of employees, few studies have focused on the relationship between organisational factors and active innovation behaviour, especially HPWS, which is common in the management structures of Chinese enterprises. Furthermore, Chinese academics are currently arguing over the issue of "Does an HPWS motivate or inhibit employees' innovation behaviour?" In order to clarify the relationship between HPWS and innovation behaviour, this study tentatively divided the internal practice of HPWS into IP and CP based on self-determination theory and explored the different effects of the two types of practices on active innovation behaviour. The results show that IP and CP have mutually exclusive influences on active innovation behaviour; namely, informational practices are positively correlated with active innovation while controlled practices are negatively correlated with active innovation. These results support the conclusion of the positive correlation between human resource management practices and innovation behaviour [65]. Furthermore, these results also help academics understand the negative effect of HPWS on active innovation behaviour, such as Voorde and Beijer [66] who believed that regulations on external factors such as strict rewards and performance weaken employees' sense of self-determination, thus making them unwilling to take risks to try new methods to resolve bottlenecks in their work. This is particularly prominent during the trade war. In a survey of high-tech enterprises in Jiangsu, Zhejiang and Guangdong, we found that up to 80% of enterprises raised their performance standards for their employees during the trade war. First, enterprises reduced their expenditure on human resources; and second, enterprises improved their competitiveness. However, it is difficult for enterprises to make major breakthroughs in technological innovation [67]. Our calculations also proved CP's greater inhibition of active innovation during the trade war, that is, CP's inhibition of active innovation (−0.36) is 1.44 times that of IP's promotion of active innovation (0.25). In subsequent interviews with employees, we found that during the trade war, strict performance management mechanisms have put them under tremendous pressure including pressure from public opinion. This has forced them to view being innovative as compulsory, which is not conducive to them feeling excited and motivated to practise innovation.

5.1.2. The Mediating Effects of the Needs for Autonomy and Competence

From the perspective of self-determination theory, this study revealed the internal mechanism by which HPWS influences the active innovation behaviour of employees. By introducing the two leading basic psychological needs—the need for autonomy and the need for competence—into the relationship between HPWS and active innovation behaviour, the results show the following: (1) the needs for autonomy and competence have relatively large mediating effects between information practices (IP) and active innovation behaviour, which are 0.12 and 0.16, respectively; (2) the need for autonomy has a relatively small mediating effect, which is 0.02, almost negligible, between controlled practices (CPs) and active innovation behaviour; and (3) the need for competence has no mediating effect between controlled practices (CPs) and active innovation behaviour. Similar to Sun et al. [68], human resource management practices such as information sharing, participation in decision making, challenging work and training in HPWS provide individuals with autonomy, thereby meeting their needs for autonomy and competence and fuel the motivation to practise active innovation behaviour. This goes a long way to explain why the needs for autonomy and competence have greater mediating effects. However, the need for autonomy has a relatively smaller mediating effect between controlled practices and active innovation behaviour—it has a "masking effect". This mediating effect weakens the negative influence of controlled practices (CPs) on active innovation behaviour. In fact, the "high-intensity and over-quantification" management model is nothing new in China's high-tech enterprises. Under this, technicians generally show working attitudes of herding, coping and utilitarianism [3]. This phenomenon was particularly prominent during the trade war. This is because China has implemented stricter overall planning for scientific and technological innovation and strengthened its orientation during this period [69]. Under China's overall management mode, enterprises can motivate employees' autonomy to a certain extent by increasing employee benefits, thus realising active innovation. As a result, employees spend considerable amounts of time increasing the applicability of products through copying and modifications, seldom developing the core technology of technological products [70]. Objectively speaking, this is also innovation to a certain extent, but it is unlikely to improve the core competitiveness of enterprises [71]. In response to the conclusion that the need for competence has no mediating effect between controlled practices (CPs) and active innovation behaviour, Ryan [26] provided an explanation that controlled practices produce a kind of pressure that mainly improves the level of an individual's external perception of causality and reduces the sense of autonomy but does not lead to a change in the perception of competence. This is consistent with the results of our interviews.

5.1.3. The Moderating Effect of the Need for Relatedness

This study explored the moderating effect of the need for relatedness in HPWS on active innovation behaviour. The results show that the need for relatedness negatively moderates the influences of HPWS on the needs for autonomy and competence, which is inconsistent with Deci and Ryan [17] who suggested that the satisfaction of the need for relatedness provides background support for the satisfaction of the needs for autonomy and competence. First, this result may be because the management and operations of China's localisation enterprises have been influenced by traditional Confucianism for a long time [72]. Instead of respecting the importance of employee innovation, managers discriminate amongst employees according to their "relationship" and "circle". In these interviews, some individuals also mentioned that superior departments or units determine the application and review of scientific and technological innovation projects based on "whether they are insiders". For technological talents with a higher need for relatedness, it is easier for them to gain the support of organisations, departments and managers and perform well in being innovative at work. In the short term, employee work autonomy and self-efficacy will be improved due to rewards or promotion opportunities with a higher degree of satisfaction of their need for relatedness. However, this will result in them

feeling too comfortable such that there will be less motivation to undergo very challenging innovation work in the long run [73]. Furthermore, in order to avoid the loss of personal benefits, employees are more likely to suppress what they truly want [74], which in turn forms the phenomena of "one person alone has the say" and "unprincipled peace" [75], reducing the creation of innovative opinions. In addition, a solid "circle" relationship will result in individuals placing reliance on others to be innovative, confine new ideas to be around their own abilities rather than on how to improve the organisation as a whole and thus weaken employee competency. Second, against the background of the trade war, China's economy is facing downward pressure, and many enterprises have suffered from capital withdrawals by foreign investors and declining profits, which have increased the unemployment rate. Employees with a lower need for relatedness are likely to experience pressure and work under the fear of unemployment. In order to eliminate this psychological feeling, they may make more effort than "insiders", participate in various training programs, acquire new knowledge and methods and improve self-efficacy to meet the need for competence. Furthermore, in order to gain the attention and favour of enterprise managers, employees are also more willing to showcase their talents and undertake difficult innovation projects [76]. Therefore, compared with less fulfilment of the need for relatedness, better satisfaction of the need for relatedness may weaken the positive influence of HPWS on the needs for autonomy and competence. This study theoretically deepens the understanding of the need for relatedness as a situational variable and verifies the negative influence brought by excessively high satisfaction of the need for relatedness of employees in a Chinese management structure during the trade war. This will help future studies to further explore the limited scope of the need for relatedness as a boundary condition under different cultures.

5.2. Practical Implications

Active innovation of the employee talent pool is an important way for high-tech enterprises to obtain sustainable core competitiveness. However, in localised enterprises with high performance pressure and a hierarchical structure, there is much "passive" innovation behaviour. Therefore, it is particularly urgent to solve the innovation dilemma of "do not want and cannot". This study has significant implications for enterprise management practices.

First, this study clarifies the relationship between HPWS and active innovation behaviour based on the important conclusion that "IP and CP have mutually exclusive influences on active innovation behaviour". First, it is recommended that high-tech enterprises prioritise the effect of informational practices, regularly conduct employee knowledge and skills training, establish standard rules and procedures and deliver positive feedback to employees, thereby inspiring them to be innovative which will strengthen an enterprise's development. Second, it is recommended that high-tech enterprises lessen or even avoid the negative effect of CP. The study of Ryan et al. [77] found that performance reward plans will become informational practices due to the different reward distribution methods. Therefore, enterprises should provide employees with appropriate rewards such as unexpected rewards, verbal praise and honorary rewards to ease the pressure on them during the trade war, reduce the effect of controlled motivation and thus encourage them to be more energetically engaged in innovation work.

Second, this study shows the importance of the needs for autonomy and competence. First, IP and CP have positive effects on active innovation behaviour through the need for autonomy. High-tech enterprises should appropriately encourage their employee talent pool to participate in decision making and provide them with work autonomy so that they can immerse themselves in innovation work and strengthen their expectations for future career development, which in turn forms a balance between the cycling and progression of challenges and skills [78]. During the trade war, while improving their performance standards, high-tech enterprises should also create platforms for free communication, relieve situational constraints [79] and encourage employees to share information and explore innovation work. Second, informational practices have a positive effect on active

innovation behaviour through the need for competence. High-tech enterprises should pay attention to job design and establish jobs such as sci-tech project development and achievement transformation without restrictions on the total number of jobs and their proportion, thus enhancing the self-efficacy of employees to meet their need for competence and increase their passion to be innovative at work.

Furthermore, this study demonstrates that the need for relatedness negatively modulates the indirect effects of the needs for autonomy and competence between HPWS and active innovation behaviour. The study explains that enterprises need to be vigilant about the "circle culture" based on the "worldly wisdom" or "human sentiment" management mode and avoid forming a strong atmosphere of competition among employees [80]. In the long run, these issues will easily lead to the outcome that those with a more satisfied need for relatedness are content with the status quo and unwilling to improve, thus reducing the motivation for innovative work and a "want to do and can do" attitude. Therefore, amidst the trade war, while building a cultural atmosphere of innovation, enterprises should seek to provide a fair reward scheme for their talent pool, strengthen employee awareness of fulfilling their responsibilities and solve the information asymmetry problem caused by different treatment amongst employees. This will weaken the negative influences of traditional Chinese cultural thinking on enterprise management practices.

5.3. Limitations and Future Research Directions

Although this study for theory research and practice application made certain contributions, there are still some limitations. First, the sample of this study focused on high-tech innovation enterprises in East China and South China. Although it can reflect the mechanism of HPWS and active innovation behaviour in such enterprises, it is essential to verify the practical guiding value of the low-tech innovation in enterprise (such as clothing, catering, shopping malls, etc.), and future research can broaden the scope of sample. Second, the variables used in this study were filled in by employees, and the data results were prone to homology errors. For example, there may be a difference between HPWS perceived by employees and HPWS implemented by the enterprise. Future research can integrate HPWS into organization-level variables for cross-level research. Finally, this study only explored the boundary effect of HPWS on active innovation behaviour from a psychological needs basis; HPWS is influenced by a multitude of factors in the implementation process. Future studies can begin with the organisational structure, superior–subordinate relationships or the interaction effects of multiple variables to further enrich the boundary conditions under which HPWS plays its role.

6. Conclusions

Based on self-determination theory, this study examined the relationship between HPWS and the active innovation behaviour of the employee talent pool under a Chinese management structure during the trade war and explored the mediating effects of the needs for autonomy and competence and the moderating effect of the need for relatedness. The results of the study show that IP and CP in HPWS have mutually exclusive influences on active innovation behaviour with significant positive and negative influences, respectively. It is worth noting that CP's inhibition of active innovation (−0.36) is 1.44 times that of IP's promotion of active innovation (0.25), which means that during the trade war, enterprises' strict performance management mechanisms do more harm than good to the active innovation behaviour of their employees. The needs for autonomy and competence have relatively large moderating effects between IP and active innovation behaviour that are 0.12 and 0.16, respectively. In addition, the need for autonomy has a relatively smaller mediating effect between CP and active innovation behaviour (0.02) and shows a "masking effect", which provides a theoretical basis for the negative influence brought by high-tech enterprises weakening their CP. Furthermore, the need for relatedness negatively moderates the two paths of HPWS to the needs for autonomy and competence, which in turn influences the entire mediating mechanism of the active innovation behaviour of employees. This

is a helpful reminder for high-tech enterprises to avoid a strong circle culture during the trade war. Therefore, we recommend that China's high-tech enterprises regularly conduct knowledge and skills training for employees, encourage them to participate in decision making, pay attention to job design and prioritise the effect of IP in HPWS during the trade war. While improving their performance standards, high-tech enterprises should also create a platform for free communication, provide various performance rewards and reduce the negative influence brought by CP in HPWS. In addition, by paying attention to the satisfaction of employees' basic psychological needs, enterprises should try their best to provide an impartial and fair employee reward mechanism, thus maximising the effects of the need for autonomy, competence and relatedness.

Author Contributions: Conceptualization, Z.S. and C.F.; Data curation, M.H., C.Y. and S.Y.; Formal analysis, C.Y.; Funding acquisition, S.Y.; Investigation, M.H.; Methodology, M.H.; Project administration, M.Y.W.; Software, M.H. and C.Y.; Supervision, C.F. and Z.S.; Validation, M.H., Z.S. and M.Y.W.; Writing—original draft, M.H.; Writing—review and editing, C.F., Z.S. and M.Y.W. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Youth Project of Jiangsu Social Science Fund (17GLC002), Fundamental Research Funds for the Central Universities (B200207090), Fundamental Research Funds for the Central Universities (B200207091) and Australian Research Council (DP170104138).

Institutional Review Board Statement: Ethical review and approval were waived for this study, due to the minimal risk involved.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The dataset generated and analyzed in this study is not publicly available. Dataset is available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A.

Appendix A.1. Basic Personal Information

1. Gender (1 = male; 2 = female)
2. Age (1 = under 25 years old; 2 = 26–35 years old; 3 = 36–45 years old; 4 = over 45 years old)
3. Education (1 = doctor; 2 = Postgraduate; 3 = Undergraduate; 4 = Junior college and below)
4. Working years (1 = 0–1 year; 2 = 1–3 years; 3 = 3–5 years; 4 = 5–10 years; 5 = more than 10 years)

Appendix A.2. High-Performance Work System Scale

1	2	3	4	5	6	7
Strongly disagree						strongly agree

1. The enterprise provides training on job skills for employees.
2. The enterprise attaches great importance to pre-job training for new employees.
3. The enterprise provides better welfare for employees.
4. The enterprise has a formal complaint procedure.
5. The grass-roots staff can respond to the suggestions of the enterprise smoothly and upward.
6. Employees get the information they need.
7. The enterprise has standardized staff performance appraisal management methods.
8. Performance appraisal is mainly based on quantitative objective standards.
9. Employee performance is linked to team performance.
10. Enterprises attach great importance to the assessment of team performance.
11. Job performance is an essential basis for an individual to get a bonus.

Appendix A.3. Autonomy Needs, Competence Needs and Relatedness Needs Scale

1	2	3	4	5	6	7
Strongly disagree						strongly agree

1. I can make my own decisions at work.
2. I often have to take orders at work.
3. I can take a different approach to my job.
4. What I want to do at work is what I have to do.
5. I do what I think is best for me at work.
6. I think I'm qualified for my present job.
7. I can finish my job.
8. I believe I can do the job well by myself.
9. I'm good at my job.
10. I can accomplish the difficult tasks in my job.
11. I get on well with my colleagues at work.
12. I feel like I'm part of a team at work.
13. I can discuss with other colleagues matters that are important to me at work.
14. I don't feel lonely at work.
15. Some of the people I work with are my close friends.

Appendix A.4. Active Innovation Behaviour

1	2	3	4	5	6	7
Strongly disagree						strongly agree

1. I can find problems in my work that need improvement.
2. I am eager to solve the problems in my work.
3. I can take the initiative in making suggestions.
4. I am proactive in looking for workflow improvements.
5. I can listen to other people's suggestions at work.
6. I actively search for relevant information before innovation.
7. I can anticipate the difficulties that may be encountered in the innovation work.
8. I take risks and innovate.
9. I'm not afraid to fail.
10. I accept responsibility for the failure of innovation.
11. I try to overcome the difficulties I encounter in the process of innovation.
12. Persist in innovation despite unfavorable conditions such as shortage of funds and time pressure.
13. Find a way out of a problem, rather than running away from it.

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